DIM OR BRIGHT: How NOT to Get Your Lights Just Right
In the series “Light Matters”, Theo Tekstra discusses the different aspects to lighting, such as quantity, quality, efficacy, special applications, new developments, and the science behind it.

I usually write about how to do things right. Unfortunately, it is sometimes much easier to explain what goes wrong. I chose 5 common errors people make when lighting their plants. It is also the five that often totally grinds my gears. See if you recognize it.

**Mistake #1**

“**The 4x4 grid**”

One of the most common questions we get is about the spacing of our fixtures. “My buddy says that they need to be spaced in a 4x4 grid (120x120cm), right?” No, that is so wrong in so many ways! Your buddy don’t know shit!

First of all, HPS lamps always give you a rectangular throw, never a square. So, the correct way to position them is in rows, where the fixtures are aligned, and to have the distance between the rows much greater than the distance between the fixtures in a row. This way you get the best overlap, penetration, and uniformity. In a square grid the light levels in the overlapping area will become way too high! This can even lead to bleaching of your crop.

Here is how a HPS lamp throws its light, seen from the top. Basically the three dimensional light spread is sort of a big donut. It is practically impossible to turn this into a square without some really serious reflector losses. The only way you can get a somewhat square field is to have the lamp vertical, and use a very specific reflector. But, as most of the light will go through your reflector in a vertical position, this leads to much greater reflector losses. The DE lamp is not even suited to run vertical.

Secondly, a 4x4’ (120x120cm) is way too small a surface for the output of this fixture. In a room with several fixtures, even in the correct positioning, that would lead to average light levels of over 1300 µmol m⁻² s⁻¹, and in most cases that will completely over-saturate your crop in between the lights. Light levels of 1000 µmol m⁻² s⁻¹ are already only for those who have absolute control of their climate and CO₂ levels, and master growing as professionals. Though in many cases, this is the optimum to get the best return from your space, it is the high end on the lighting scale. Unless you really know what you are doing, don’t go that high. If you are not so sure, you should stick to 700-800 µmol m⁻² s⁻¹ average, and you will get much better results (you can always choose to boost 15%). More is not always better. Here is an example of how, in a 10 light room, your lamps should be positioned for an optimal grow room with high light levels. In the previous edition of Garden Culture, I explained how you can optimize your grow space for light, and how to deal with positioning. Read it in UK 13/US 11 on [www.bit.ly/GC-mags](http://www.bit.ly/GC-mags).
Mistake #2 -
"Open reflectors are deep reflectors"

So, air cooled (AC) reflectors are wider reflectors? Wrong! Open reflectors, like our HR96, are actually much wider reflectors than air cooled reflectors, and bring most of the light outward instead of straight under the lamp.

First of all, let’s look at the light spread of air cooled reflectors. Air cooled reflectors are deeper by default, because they have a glass filter installed. This causes refraction and reflection of light through glass: at angles >41 degrees the light reflects back into the reflector, so air cooled reflectors are seldom any wider than 85 degrees. You will need more distance for uniform light levels, as the intensity straight under the light is a lot higher.

Open DE reflectors are much wider, and actually bring more light to the sides than straight under the lamp. They are designed to overlap, and through overlap create the best (horizontal and vertical) uniformity and penetration of your crop, as the light comes in at a much lower angle. Remember, the sun is never straight above your plants all the time.

The difference in spread can best be illustrated in a polar diagram that shows you the light exit angle from the reflector, from left to right: The first two diagrams show the light angle of 2 popular “deep” reflectors, the third is an open reflector spread.

Open reflectors create light uniformity, horizontally, as well as vertically:

The best uniformity and intensity of light you get in the centre of the room, because only at the walls you will lose light. We recommend that you use no paths but rolling benches, and keep a perimeter around your crop, for optimal utilization of your light and the best results.

Mistake #3 -
"The 1-1 replacement"

So, you are a grower, and you are using 1000W single-ended lamps in a large air cooled reflector, and you are thinking about changing to DE fixtures. You have already grown in your current setup for several years, and your room is dialed in just right. However, you want to take it to the next level, and replace your air cooled hoods with open DE reflectors at the same position. Suddenly things go bad. Crops crumble, bleach, you are getting heat problems, and unless you dim your lights, things do not improve at all! WTF super awesome DE?

We are going deeper down the rabbit hole now… Let’s look again at the light that reaches your crop. Air cooled single-ended fixtures result in lower light output, because of the reflection back into the reflector, and the extra reflector losses you get because of that - the losses by having to go through glass, and the losses because the glass filter is never completely clean. Add the higher output of the double-ended (DE) lamps, plus the fact that users never replace their AC reflector (which reflectivity deteriorates as well over time), and you understand why good DE fixtures output sometimes way more light on average, at the same power use!

Keep in mind what you learned about positioning: Replacing lamps that hang in a 4x4 grid can create serious overlap problems, resulting in extremely high light levels.

So, replacing old fixtures with DE’s can seriously increase your light levels, up to values that are no longer healthy for your plants. If you are already growing at high light levels, that is a real showstopper. A waste of energy too.

Unfortunately, most growers buy 1000W fixtures to replace 1000W fixtures (bigger is better, right?) instead of 600 or 750W fixtures, and then dim them down to 750 to get desirable light levels. That’s actually another common mistake. Running a 1000W lamp at 750W is really not that efficient, and it will have a worse spectrum. Always right-size your lighting!
Mistake #4 – “I’ll just overlap lights over my plants”

Many growers position fixtures straight above their plants so they overlap over the plants, and not in the paths. Let me illustrate that for you by showing the same light plan with the reflectors rotated just above the plant.

First, we have the positioning as we recommend, using the same positioning as in the earlier shown example to light our complete room:

I am showing you the complete room, and just one side to zoom in on where a table is. You see the room is lit in a very uniform way, the highest light intensity hardly 7% more intense than the average light level, meaning there are no peaks in light, no “hot-spots.”

Now, let’s look at what happens if we rotate the reflectors 90 degrees, to overlap the light over our tables at the left and right of the room:

This is the same calculation with a single-ended air cooled reflector, also at 3.5 feet (106 cm) away from the plants. For this calculation, we used the best single-ended lamp and AC reflector we could find! First, look at the scale. Every color now represents 200 µmol m⁻² s⁻¹ light difference to reflect the much lower uniformity. Average light levels are about 30% higher with DE configuration. You see you will have peaks (hot spots) of more than 50% higher than the average light levels! “Not fair!” I hear you say. “You have them turned the wrong way around. This is not how they should be used.” Ok then, let’s rotate them 90 degrees. However, this is not how most people use them in reality.

First of all, look at the scales compared to the previous diagrams, because they represent different light levels. The highest light levels in this example are >1100 µmol m⁻² s⁻¹ (hot spots). That is a dramatic change in high light levels! Though the average light level did not increase much at all, the peaks are a whopping 19% higher, peaking at over 1100 µmol m⁻² s⁻¹! And still you see a lot of light getting lost between the tables. In this sample, even with the rotated lamps, at least 10% of the light would still get lost.

“No problem”, you’ll say. “I will just use an air cooled reflector. As you explained to me, they have a glass filter, so they should not be as wide, and I can come a lot closer to the crop. That will prevent that high level overlapping light, and light loss.”

That may sound logical, but because of that deeper reflector you will need much more distance from that reflector to get good uniformity, or you will have extremely high light level differences. Remember, these calculations were made with the reflector 3.5’ (106 cm) away from the crop!
Indeed, fixtures in line gives a much better result: You see a better uniformity (although still a lot worse than the overlapping open DE’s). This also proves that all horizontal reflectors, even air cooled reflectors, give you a rectangular spread. But look at the average light level, uniformity, and peaks. Using the DE open reflector still results in average 30% more light, and the peaks of the air cooled are still 30% higher than the average light level, with the peaks straight under the lamps. So actually you would get more light on your crop, even using separate tables, by lighting your whole room with DE reflectors. Of course not all DE reflectors are made the same and light spread/uniformity can vary greatly between manufacturers.

**Mistake 5 - “Air cooled lamps can hang closer to my plants”**

Let’s dismiss another fable: “Lights can not come close to the plants, because of all the heat (radiation), so using air cooled hoods lets you come closer to the plant.” Sounds pretty logical, right?

The reality, however, is a bit more complicated. AC reflectors output less light, specifically the single-ended fixtures - up to 40% less. They distribute light at a smaller angle (deeper reflector by design), so they concentrate a lot of light straight onto a smaller surface. They give a higher intensity straight under the lamp, and that intensity could even be a lot higher than a DE lamp when you come close to your crop. Indeed, they create less heat on your plants, but at the right light levels you should not have any problem with that anyway! So, they are actually masking the fact that they give less light overall, and at close distances, too high light levels directly under the lamp.

In fact, we have seen that an air cooled reflector should be hung a bit higher than an open reflector to get good uniformity, because the air cooled is a deeper reflector. The average light levels, however, because of the air cooled reflector, are lower. The uniformity will never be as good as with the specially designed DE reflectors.

**So there you have it.**

**My top 5 mistakes in lighting:**

- Square positioning
- Incorrect intensity and bad uniformity
- Too many lamps
- Lighting just plants instead of rooms
- Your buddy!